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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/811,866	03/30/2004	Amit Marathe	50432-123	3796

7590 09/01/2005  
McDERMOTT, WILL & EMERY  
600 13th Street, N.W.  
Washington, DC 20005-3096

EXAMINER
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NGUYEN, THANH T

ART UNIT	PAPER NUMBER
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2813

DATE MAILED: 09/01/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

## Office Action Summary

Application No.

10/811,866

Applicant(s)

MARATHE ET AL.

Examiner

Thanh T. Nguyen

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

### Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
  - If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
  - If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
  - Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

### Status

- 1) ☒ Responsive to communication(s) filed on 29 June 2005.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

### Disposition of Claims

- 4) ☒ Claim(s) 1-18 is/are pending in the application.
- 4a) Of the above claim(s) 1-10 is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 11-18 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

### Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

### Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
  - ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.

### Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)  
Paper No(s)/Mail Date \_\_\_\_\_
- 4) ☐ Interview Summary (PTO-413)  
Paper No(s)/Mail Date. \_\_\_\_\_
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: \_\_\_\_\_

## **DETAILED ACTION**

### ***Election/Restrictions***

Applicants election of Group II (method claims 11-18) is acknowledged. Because applicant did not distinctly and specifically point out the supposed errors in the restriction requirement, the election has been treated as an election without traverse (MPEP 818.03(a)).

Claims 1-10 are withdrawn from further consideration by the examiner, 37 C.F.R. 1.142(b) as being drawn to a non-elected invention.

### ***Oath/Declaration***

Oath/Declaration filed on 3/30/04 has been considered.

### ***Specification***

The title of the invention is not descriptive. A new title is required that is clearly indicative of the invention to which the claims are directed.

### ***Claim Rejections - 35 USC § 103***

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be

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patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 11-18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tang et al. (U.S. Patent Publication No. 2003/0089597) in view of Chiras et al. (U.S. Patent No. 2005/0118796).

Referring to figures 4a-5g, Tang et al. teaches a method of manufacturing a semiconductor device, the method comprising:  
forming an opening (via, 402) in a dielectric layer (403) over a semiconductor wafer;  
forming a composite barrier layer (405/420/422) with an exposed surface of the opening, the composite barrier layer comprising a layer of  $\alpha$ -tantalum  $\alpha$ -Ta (422) over an initial layer of tantalum nitride (TaN, 405/420); and filling the opening with copper (Cu) or a Cu alloy (424, see paragraph# 109).

12. depositing a graded tantalum nitride layer (420, called seed layer) on the initial TaN layer lining (405) the opening (403); and depositing the  $\alpha$ -Ta layer (422) on the graded tantalum nitride layer (420, see figure 4E, paragraph# 108-109).

13. depositing the TaN layer by ionized sputter deposition using a Ta target and a sufficiently high nitrogen (N<sub>2</sub>) flow rate to poison the Ta target with N<sub>2</sub> (see paragraph# 85, see figures 4a-5g);

discontinuing the flow of N<sub>2</sub> (Noted that it is obvious that before depositing a tantalum layer one has to stop the flow of nitrogen gas because if there is nitrogen left it will form a tantalum nitride film); and

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depositing the graded tantalum nitride and  $\alpha$ -Ta layers using the Ta target (see paragraph# 117).

14. depositing the TaN layer using a nitrogen (N<sub>2</sub>) flow rate (see paragraph# 85, see figures 4a-5g); ; and

controlling the surface roughness (Ra) by varying (see paragraph# 19-20, 50-51, and claim 1):

a) the ratio of the thickness of the combined  $\alpha$ -Ta and graded tantalum nitride layers to the thickness of the initial TaN layer; and/or

b) the N<sub>2</sub> flow rate during deposition of the TaN layer.

17- the opening is formed in dielectric material having dielectric constant less than about 3.9 (silicon dioxide, it is inherent that silicon dioxide has a dielectric constant less than about 3.9).

Tang et al. teaches all of the limitations as described in the claim invention above. However, the reference does not teach a dual damascene opening, the specific surface roughness, nitrogen flow rate and the thickness of the barrier layer as well as the ratio of thickness of the layer.

Chiras et al. teaches a method of forming an interconnect with a dual damascene opening (18), forming a barrier layer tantalum nitride (20), alpha tantalum (22) in the opening (18) wherein the flow rate of nitrogen is between 10-100 sccm (see paragraph# 35), and forming a copper in the opening (see paragraph# 41).

Therefore, it would have been obvious to a person of ordinary skill in the requisite art at the time of the invention was made would form an interconnect with a dual damascene in process of Tang et al. as taught by Chiras because the process would reduce

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field induces metal contamination of dielectric by metallic interconnect in a via and/or leakage failure of the metallic interconnect (see paragraph# 7)

The concentration range of claims 3-5, 9, 14-16, 20, and 35-38 and the concentration range of claims 6-8, and 17-19 are considered to involve routine optimization while has been held to be within the level of ordinary skill in the art. As noted in *In re Aller*, the selection of reaction parameters such as temperature and concentration would have been obvious:

Normally, it is to be expected that a change in temperature, or in concentration, or in both, would be an unpatentable modification. Under some circumstances, however, changes such as these may impart patentability to a process if the particular ranges claimed produce a new and unexpected result which is different in kind and not merely degree from the results of the prior art...such ranges are termed critical ranges and the applicant has the burden of proving such criticality.... More particularly, where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation.

*In re Aller* 105 USPQ233, 255 (CCPA 1955). See also *In re Waite* 77 USPQ 586 (CCPA 1948); *In re Scherl* 70 USPQ 204 (CCPA 1946); *In re Irmischer* 66 USPQ 314 (CCPA 1945); *In re Norman* 66 USPQ 308 (CCPA 1945); *In re Swenson* 56 USPQ 372 (CCPA 1942); *In re Sola* 25 USPQ 433 (CCPA 1935); *In re Dreyfus* 24 USPQ 52 (CCPA 1934).

Therefore, one of ordinary skill in the requisite art at the time the invention was made would have used any thickness range and the flow rate range suitable to the method in process of Tang in order to optimize the process.

### ***Conclusion***

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Thanh Nguyen whose telephone number is (571) 272-

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1695, or by Email via address Thanh.Nguyen@uspto.gov. The examiner can normally be reached on Monday-Thursday from 6:00AM to 3:30PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead, can be reached on (571) 272-1702. The fax phone number for this Group is (571) 273-8300.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Group receptionist whose telephone number is (703) 308-0956 (See MPEP 203.08).

A handwritten signature in black ink, appearing to read 'Thanh', with a stylized flourish extending to the right.

Thanh Nguyen  
Patent Examiner  
Patent Examining Group 2800

TTN